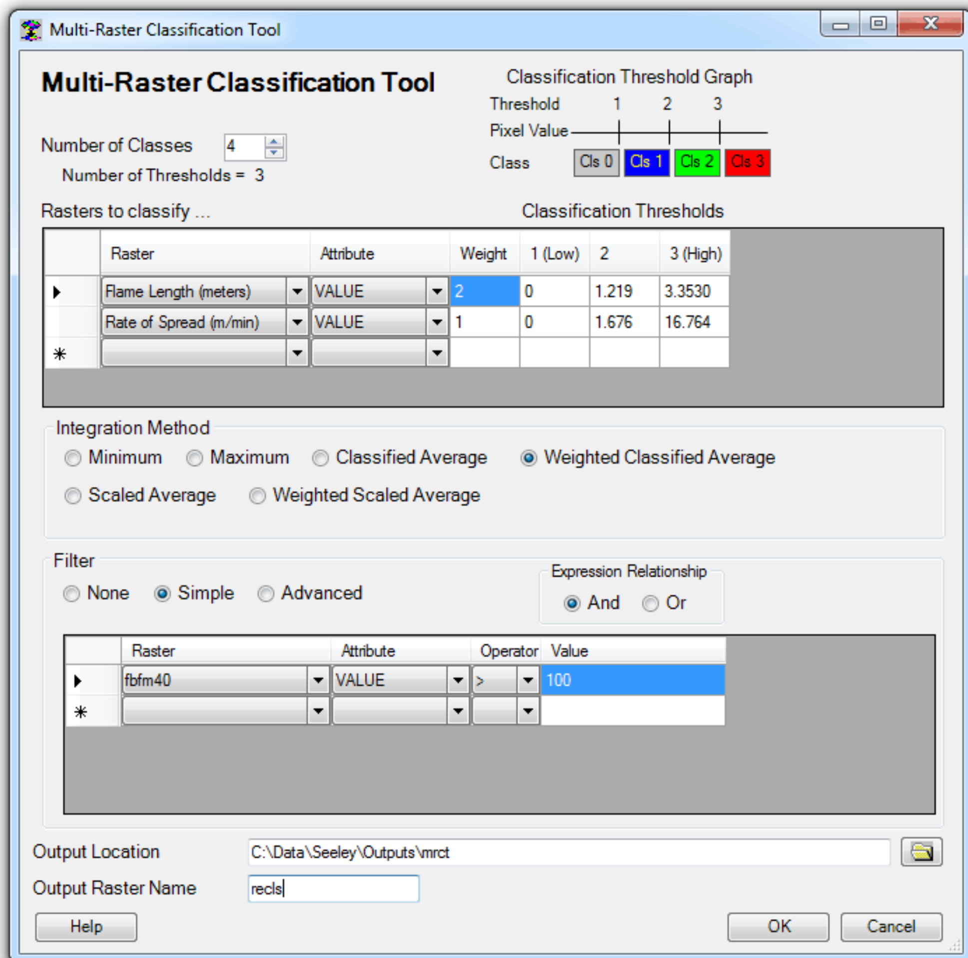
Multi-Raster Classification Tool

User's Guide

Version 1.0

November 2012



1. Introduction

The Multi-Raster Classification Tool (MRCT) is a custom ArcMap tool that allows a user to classify multiple ArcGRIDs into a single classified output ArcGRID. The user specifies the number of classes, the classification thresholds for each of the input rasters, the integration method, and the ArcGRIDs to be used for filtering the output raster.

This document is created for version 1.0.0 MRCT, which requires ArcGIS 10. It is important to have the most current ArcGIS service pack installed, which can be downloaded from http://support.esri.com.

We value your input. Please forward any questions, comments, reports of bugs, or ideas to the National Interagency Fuels, Fire, and Vegetation Technology Transfer (NIFTT) at helpdesk@niftt.gov.

1.1 Computer Requirements

Ensure that the following programs are installed and functioning properly on your computer:

- ArcGIS 10 with current service pack installed
- Spatial Analyst extension of ArcGIS

Although system requirements to run ArcGIS 10 will suffice to run MRCT, at least 10 GB of free hard drive space and 2 GB of RAM are recommended. Generally, faster processors, more memory, and increased free hard drive space will improve performance. In addition, NIFTT tools were developed for Windows Operating Systems.

1.2 Credits

The Multi-Raster Classification Tool was developed for the National Interagency Fuels and Fire Technology Transfer (NIFTT) by Dale Hamilton of Systems for Environmental Management (SEM LLC). Technical guidance was provided by Jeff Jones of the USDA Forest Service.

The Multi-Raster Classification Tool User's Guide was written by Dale Hamilton of SEM LLC.

2. Multi-Raster Classification Tool Function

The Multi-Raster Classification Tool (Figure 2-1) allows the user to classify multiple rasters into a single output raster. In addition to which rasters will be used in the classification, the user has the opportunity to specify the thresholds that will be used in classifying each of the rasters. MRCT will classify each of the individual rasters according to the thresholds specified by the user. The user will also be able to apply a filter which will allow them to specify which pixels will be included in the classification.

Classifying multiple rasters requires that the MRCT query the user for a variety of inputs, both spatial and non spatial. These include the number of classes the output raster will contain, the rasters that will be classified, the integration method used in classifying the rasters, the filter to be applied to the classification and the location and name of the output raster. The user can also specify a set of filtering rasters and conditions upon which MRCT will determine which pixels in the input rasters will be included in the classification.

The MRCT classifies the input rasters based on the classification thresholds and integrates the individual classifications into a single classified output raster, omitting pixels that do not meet the criteria specified in the filter.

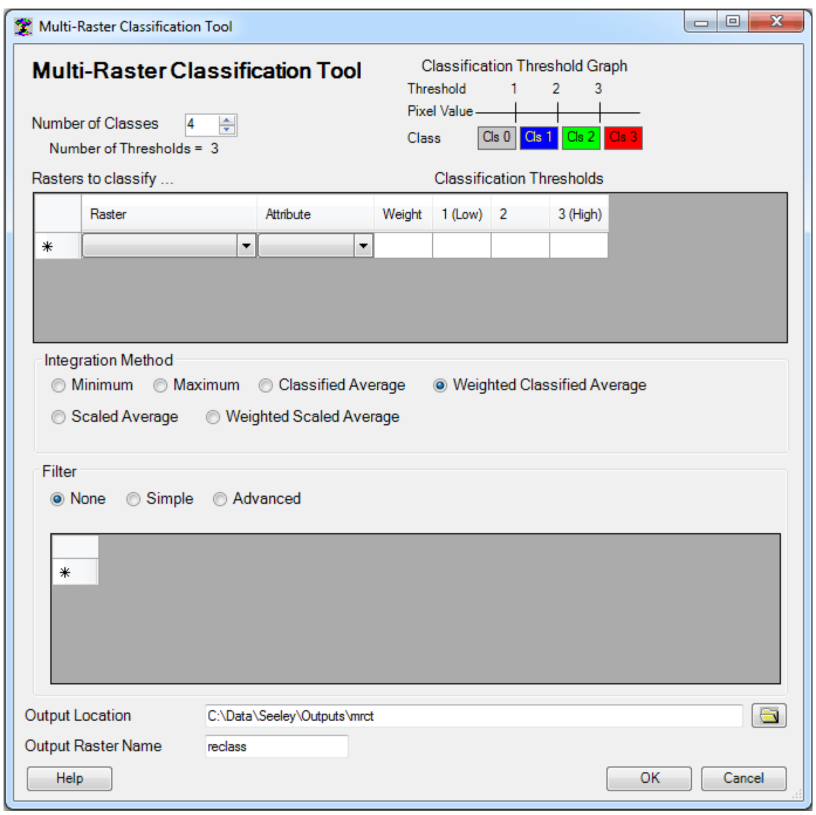


Figure 2-1: The Multi-Raster Classification Tool.

3. Input Data

In order to classify the input rasters, the MRCT queries the user for the following inputs:

3.1 Number of Classes

Number of Classes (Figure 3-1) allows the user to specify how many classes the output ArcGRID will contain. The user can select from 2 to 7 classes. The Classification Thresholds are the bounds for each of the classes for the rasters, so there will be one less threshold than there will be classes. The number of thresholds is indicated with the *Number of Thresholds* which will always be one less than the *Number of Classes*. The relationship between the classes and thresholds is illustrated in the *Classification Threshold Graph* shown in Figure 3-1.

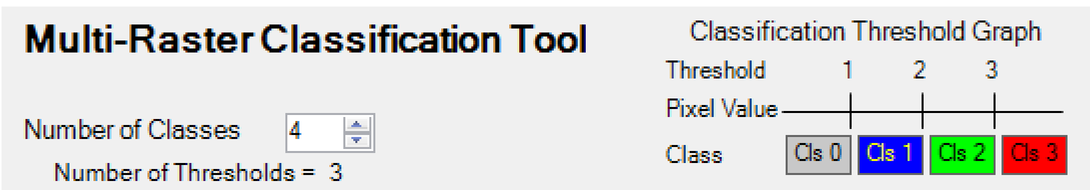


Figure 3-1: *Number of Classes* and *Classification Threshold Graph.*

3.2 Rasters to Classify

Rasters to classify (Figure 3-2) allows the user to specify which ArcGRIDs will be used as inputs for the classification. The dropdown boxes in the *Raster* column allows the user to select any ArcGRID that is loaded into ArcMap and shows up on the ArcMap Table of Contents (TOC). In addition to specifying which rasters to use, the user also can specify which attribute to classify on and what thresholds to use for classifying each input ArcGRID. If one of the weighted integration methods is being used, the user also can input the weighting factor for each of the input ArcGRIDs.

The *Raster* column is a dropdown box which contains the layer names of all the ArcGRIDs on the Table of Contents. To include an ArcGRID as an input, simply select that ArcGRID from the list in the dropdown.

The *Attribute* column is a dropdown that contains the names of the attributes which can be used when including an ArcGRID in the classification. Only numeric attributes are included in the dropdown list being as ArcGRIDs can only be classified by numeric values. If an attribute is not selected, the Multi-Raster Classification Tool will use the Value attribute by default.

If the user selects either the *Weighted Classified Average* or the *Weighted Scaled Average* integration methods, the *Weight* column is visible. This allows the user to specify the weighting factor to be applied to the classification of each of the input rasters when they are integrated into a single output.

One or more *Classification Thresholds* columns will be available based on how many classes the user has specified. The classification thresholds allow the user to designate the dividing points the ranges of values that will be included in each of the classes for the input rasters. Consequently there will be one less threshold than there are classes with the possible number of thresholds ranging from 1 to 6. The first threshold will designate the dividing point between class 0 and class 1, with pixels that have a value less than or equal to the first threshold being set to class 0. The highest threshold will designate the dividing point between the highest and the next to highest classes. For example, if the user sets *Number of Classes* to 4, there will be 3 thresholds. Threshold 1 will be the dividing point between Class 0 and

Class 1, threshold 2 will be the dividing point between class 1 and class 2 and threshold 3 will be the dividing point between class 2 and class 3.

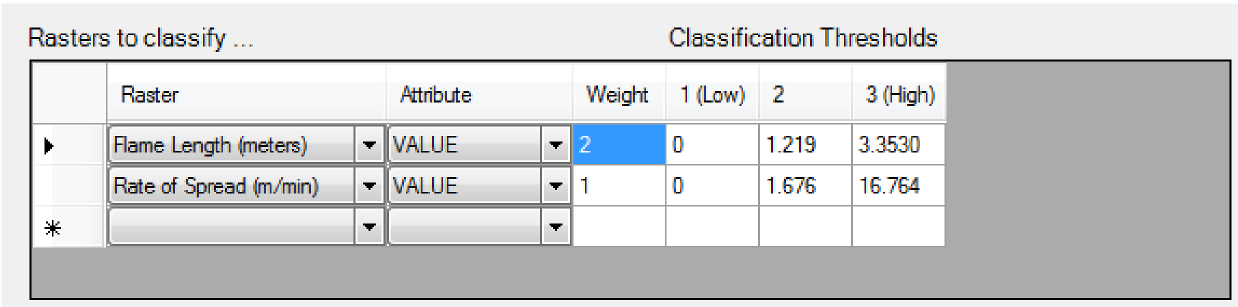


Figure 3-2: ***Rasters to classify*** **with** ***Weight*** **column resulting from selecting one of the weighted average integration methods in addition to three classification thresholds.**

In the example in Figure 3-2, MRCT is classifying on Flame Length and Rate of Spread rasters. One of the weighted average integration methods was selected, so we were able to specify that Flame Length will be weighted twice as heavily in our evaluation. The first threshold for both rasters is set at 0 (which represents no fire) so we will be able to separate the unburned pixels into class 0. The remaining Flame Length thresholds were set at 1.219 meters (4 feet) and 3.3530 meters (11 feet). Those thresholds are based on the Hauling Chart (Rothermel 1983; Roussopoulo 1974). The remaining Rate of Spread thresholds were set at 1.676 m/min (5 ch/hr) and 16.764 m/min (50 ch/hr). The Rate of Spread thresholds are from Scott and Burgan (2005). As you can see from the conversions (English to Metric) we did from the thresholds in the original publications to the values we used in MRCT, it's important to make sure that the thresholds are in the same units as the data being are classified. There are a variety of output rasters from the Wildland Fire Assessment Tool (WFAT) or the Fire Regime Condition Class (FRCCMT) which can conveniently be used as input rasters for the MRCT. Table 3-1 shows a list of common thresholds that can be used when classifying rasters from these NIFTT tools with MRCT.

	Low	High	Units	Source (more detail in Appendix A)
Flame Length	1.219	3.3530	Meters	Hauling Chart
Rate of Spread	1.676	16.764	m/min	Scott and Burgan, 2005
Fireline Intensity	550	4000	kW/m	Alexander, 1982
Consumed Total Fuel Loading	33	66	%	LANDFIRE Refresh Methods Document (Hann and others, 2012)
PM 2.5 Emissions			lbs/ac	LANDFIRE Refresh Methods Document
Soil Heating (60C)			Cm	LANDFIRE Refresh Methods Document
Stratum Vegetation Departure	33	66		FRCC Guidebook (Barrett and others, 2010)
Stratum Regime Departure	33	66		FRCC Guidebook
Fire Regime Departure	33	66		FRCC Guidebook
Stand Departure	5	80		FRCC Guidebook

Table 3-1: Common thresholds for various rasters.

To help the user visualize the relationship between the thresholds and the classes, MRCT has Classification Threshold Graph to help illustrate the relationship between the classification thresholds and the classes. As the graph in Figure 3-3 shows, the user has specified that there will be four classes, which will result in the user being queried to supply three thresholds for each of the rasters that will be included in the classification. The graph shows that pixels with a value less than or equal to threshold one will be assigned class zero, pixels with a value less than or equal to threshold two will be assigned class one, pixels with a value less than or equal to threshold three will be assigned class two and pixels with a value greater than threshold three will be assigned class three. The color of the classes in the graph corresponds to the color that pixels of that class will be given when the output raster is symbolized and loaded into ArcMap.

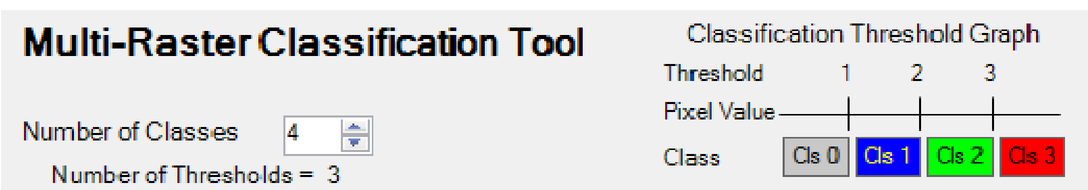


Figure 3-3: *Number of* Classes And *Classification Threshold Graph*. The user has specified that there will be four classes, which will result in three thresholds.

3.3 Integration Method

Integration Method (Figure 3-4) allows the user to specify the method the MRCT will use to synthesize the classifications of the individual rasters into a single classification. There are six integration methods that MRCT allows the user to choose between, each of which is discussed below. Each of the integration methods look at the classified values from the input rasters on a pixel by pixel basis, then synthesize the multiple values for each pixel into a single value in the output raster for the corresponding pixel.

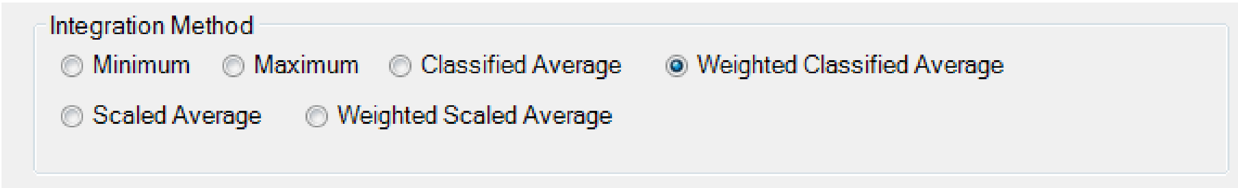


Figure 3-4: Integration Methods

3.3.1 Minimum Integration Method

The *Minimum* integration method will evaluate the classified values from the input rasters on a pixel by pixel basis, placing the lowest value in the corresponding pixel in the output raster.

3.3.2 Maximum Integration Method

The *Maximum* integration method will evaluate the classified values from the input rasters on a pixel by pixel basis, placing the highest value in the corresponding pixel in the output raster.

3.3.3 Classified Average Integration Method

The *Classified Average* integration method will evaluate the classified values of the input rasters on a pixel by pixel basis. The classified values for each of the rasters are summed up for the pixel, then divided by the number of rasters being classified. This value is then rounded to the nearest integer, which will be placed in the corresponding pixel in the output raster. The Classified Average can be represented with the following equation:

Classified_Avg = round(sum(Raster_Classified_Value)/Raster_Count))

3.3.4 Weighted Classified Average Integration Method

The *Weighted Classified Average* integration method will evaluate the classified values of the input rasters on a pixel by pixel basis. For each pixel, the classified values for each of the rasters are multiplied by the raster's weighting factor, then summed up for the pixel. The weighted sum is then divided by the sum of the weights for each of the rasters. This average is then rounded to the nearest integer, which is placed in the corresponding pixel in the output raster. The Weighted Classified Average can be represented with the following equation:

Weighted_Classified_Avg = round(Weighted_Sum(Raster_Classified_Values)/Sum_of_Weights))

3.3.5 Scaled Average Integration Method

The *Scaled Average* integration method will evaluate the classified values of the input rasters on a pixel by pixel basis. A scaled classified value is calculated for each raster's value for a pixel, where the scaled classified value represents the proportional representation of the value in relation to the thresholds above and below it. For example, assume a value for a given pixel for a raster is 77, the next threshold below it is threshold 2 at a value of 70 and the next threshold above it is threshold 3 at a value of 80. The pixel value of 77 is 70 percent of the way between threshold 2 and threshold 3, so it would get a scaled classified value of 2.7. The scaled classified values for each of the rasters are summed up for the pixel, then divided by the number of rasters being classified. This value is placed in the corresponding pixel in the output raster. The Scaled Average can be represented with the following equation:

Scaled_Avg = round(sum(Raster_Scaled_Value)/Raster_Count))

3.3.6 Weighted Scaled Average Integration Method

The *Weighted Scaled Average* integration method will evaluate the classified values of the input rasters on a pixel by pixel basis. A scaled classified value is calculated for each raster's value for a pixel, where the scaled classified value represents the proportional representation of the value in relation to the next thresholds above and below it. For example, assume a value for a given pixel for a raster is 77, the next threshold below it is threshold 2 at a value of 70 and the next threshold above it is threshold 3 at a value of 80. The pixel value of 77 is 70 percent of the way between threshold 2 and threshold 3, so it would get a scaled classified value of 2.7. The scaled classified values for each of the rasters are multiplied by the raster's weighting factor then, summed up for the pixel. The sum is then divided by the sum of the weights of the rasters being classified. This value is placed in the corresponding pixel in the output raster. The Weighted Scaled Average can be represented with the following equation:

Weighted_Scaled_Avg = round(Weighted_Sum(Raster_Scaled_Value)/Sum_of_Weights))

3.4 Filter

The *Filter* allows the user to specify which pixels from the input rasters will be included in the raster classification. By default, the filter is set to *None* (Figure 3-5), which indicates that all pixels from the input rasters will be evaluated and included in the classification, resulting in classified values in all the pixels in the output raster.

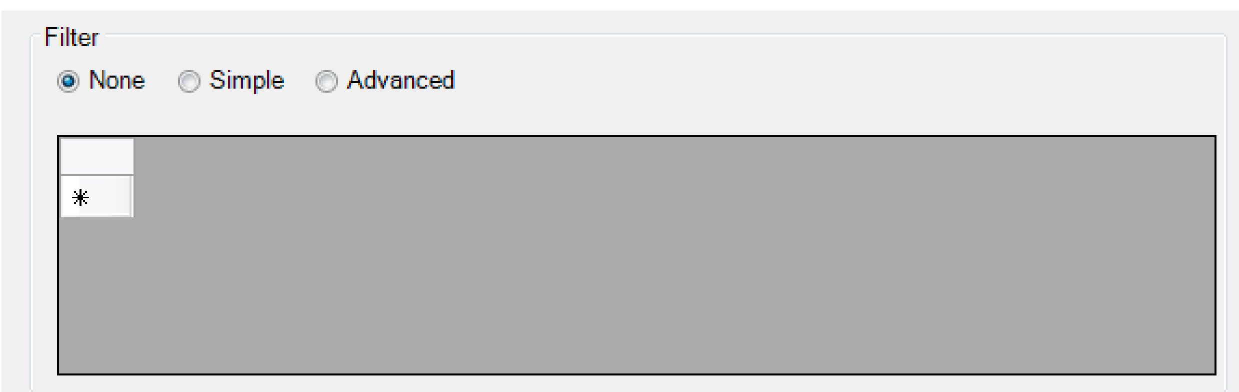


Figure 3-5: *Filter* set to *None* by default.

When the *Filter* is turned on to either *Simple* or *Advanced*, the user can specify one or more conditions that will have to be met for each pixel to be included in the classification. If the condition is not met for a pixel, that pixel will get a value of NoData in the output raster.

One exception to pixels receiving a classified output value if they meet the criteria in the filter is if the values in one or more of the input or filter rasters is NoData for that pixel. In that case, the output raster will also receive a value of NoData for that pixel.

3.4.1 Simple Filter

The *Simple* Filter (Figure 3-6) allows the user to specify conditions that must be met in order for pixels to be evaluated and included in the output raster. The user specifies the *Raster* from the ArcMapTOC that will be included in the filter and the *Attribute* which the filter will check values in. The *Operator* and *Value* fields allow the user to specify the condition which must be true for the values in the *Attribute* in order for pixels to be evaluated and included in the output raster.

The simple filter assumes that if there is more than one condition is specified, that all the conditions will all be joined by either an *And* or an *Or* expression relationship*.* Figure 3-6 shows an example where in order for a pixel to be included in the output, the VALUE attribute for the FBFM40 raster must be greater than 100 and the VALUE attribute for the FLM raster must be less than 900. This filter has the effect of excluding pixels where either the FBFM40 or the FLM have model codes which indicate that the pixel is non-burnable.

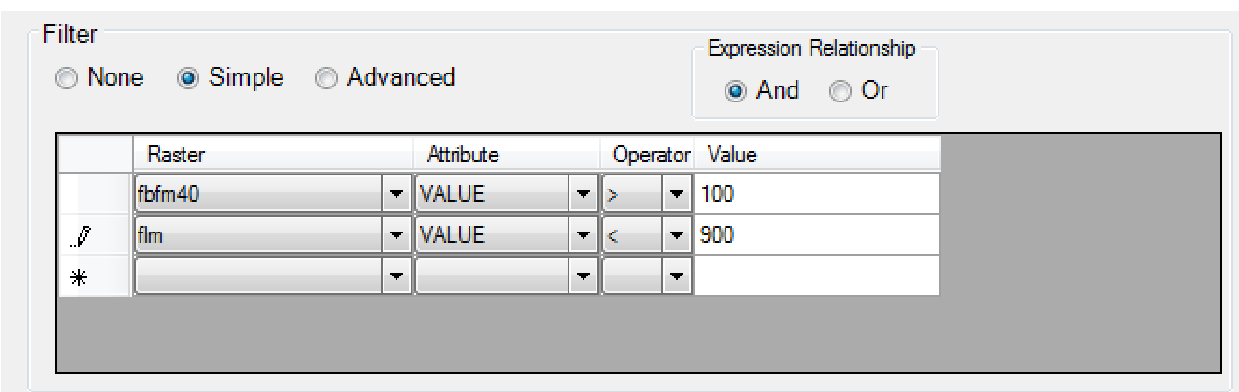


Figure 3-6: A *Simple* Filter setup to ensure pixels in the output raster get a value of NoData if either the FBFM40 or FLM rasters have a non-burnable value for that pixel.

3.4.2 Advanced Filter

The *Advanced* Filter (Figure 3-7) allows the user to specify conditions which use both *And* and *Or* expression relationships. In order to specify the order in which sub-conditions are to be evaluated, MRCT provides the ability to group sub-conditions within parenthesis. For example, assume that we want to only evaluate pixels where the FLM is burnable (a VALUE of less than 900) and the FBFM40 indicates high shrub loading (a value of either 145 or 147 based on the FBFM40 Attribute Data

Dictionary available on the LANDFIRE website (www.landfire.gov)). See the attribute table in Figure 3-8 which illustrates the values FBFM40 would need to have. The condition would be written as:

(fbfm40.VALUE = 145 or
fbfm40.VALUE = 147) and
flm.VALUE < 900

The parenthesis around the two fbfm40 sub-conditions ensures that those sub-conditions will be evaluated before their result is evaluated with the FLM sub-condition. This condition would be expressed in MRCT as shown in Figure 3-7.

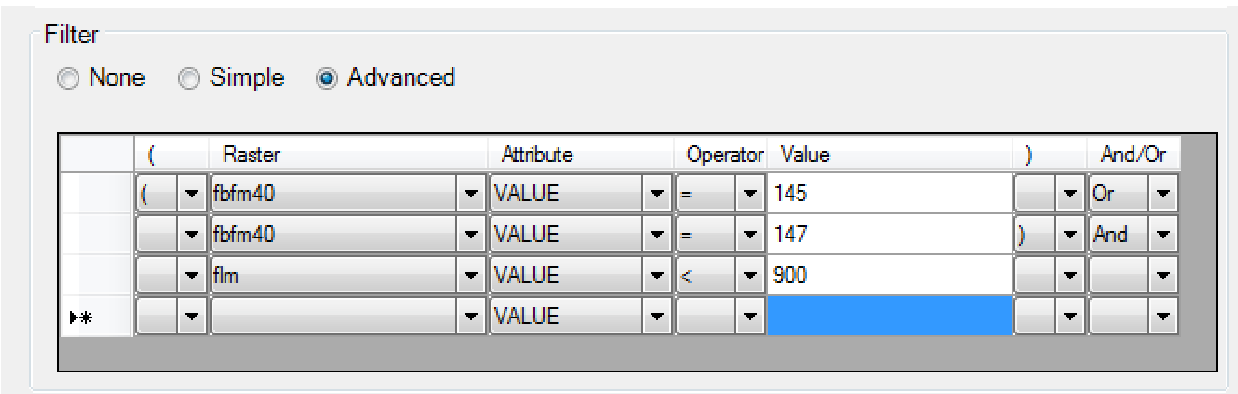


Figure 3-7: *Advanced* Filter setup to ensure that only burnable FLMs and high fuel load shrub FBFMs are evaluated. Note the parenthesis around the FBFM40 sub-conditions which ensure that they are evaluated before their result is evaluated with the FLM condition.

fbfm40

Rowid	VALUE	COUNT	FBFM40
0	91	6178	NB1
1	93	21229	NB3
2	98	21659	NB8
3	99	4844	NB9
4	101	29854	GR1
5	102	318700	GR2
6	107	27	GR7
7	121	17611	GS1
8	122	217753	GS2
9	141	23	SH1
10	142	44895	SH2
11	145	168	SH5
12	146	1445	SH6
13	147	187932	SH7
14	161	1651	TU1
15	162	3546	TU2
16	165	225915	TU5
17	183	842508	TL3
18	186	2211	TL6
19	188	255771	TL8

Figure 3-8: Attribute table from a sample FBFM40 ArcGRID.

4. Output Data

MRCT generates a single output raster that contains the results of the classification. The user specifies the *Output Raster Name* (Figure 4-1) which is the name that will be assigned to the output ArcGRID as well as the *Output Location* which is the folder where the output raster will be placed. Clicking on the browse button to the right of *Output Location* will open a *Browse For Folder* dialog which will allow the user to navigate to the desired folder.

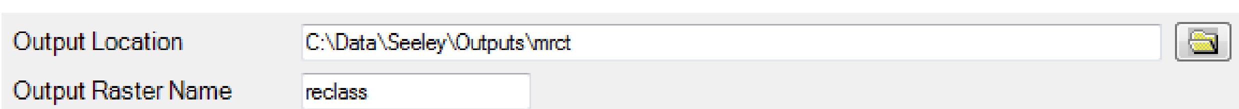


Figure 4-1: *Output Location* and *Output Raster Name.*

The output raster is an integer raster with values from 0 to the number of classes minus 1. Figure 4-2 shows an example MRCT output called *reclass* which was created with 4 classes. The legend in the TOC for the raster shows that *reclass* has four classes:

0 – Very Low
1 – Low
2 – Medium
3 - High

The legend also shows that these classes are symbolized with the same colors as were shown on the *Classification Threshold Graph* (Figure 3-3).

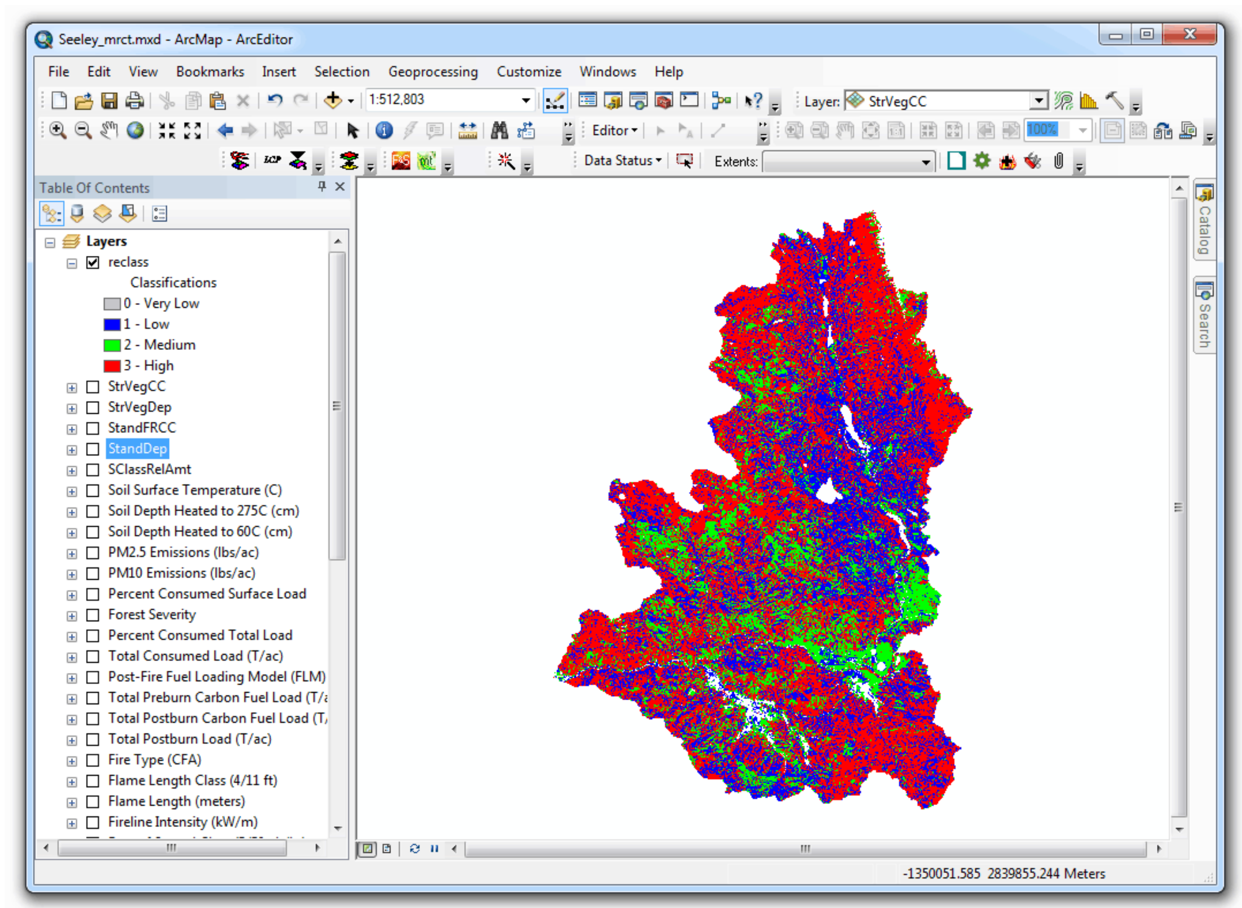


Figure 4-2: ArcMap with raster called *reclass*, an output from MRCT.

Appendix A:References

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